Quest Journals
Journal of Research in Applied Mathematics
Volume 8 ~ Issue 4 (2022) pp: 30-36
ISSN(Online) : 2394-0743 ISSN (Print): 2394-0735
www.questjournals.org

Research Paper

A Time Truncated Special Purpose Double Sampling Plan DSP (0,1) for Akash Distribution

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ABSTRACT: *In this paper, we develop special purpose double sampling plan DSP(0,1) based on truncated life tests for the Akash Distribution. The minimum sample size required for ensuring the specified mean life at consumer's confidence level has been determined. The Operating Characteristics values for various quality levels are obtained and the results are discussed with the help of tables and examples.*

R*eceived 10 Apr, 2022;* ***R****evised 25 Apr, 2022;* ***A****ccepted 27 Apr, 2022 © The author(s) 2022.*
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I. INTRODUCTION:

In a competitive economy, goods stand in the market if they are of good quality. A consumer wants products of good quality at reasonable and affordable prices. Here the 'quality' can be defined in two different ways. In one sense, goods are said to be of good quality if they meet the expected functional use. Example for second concept, ball-bearings within the specification limits is said to be in control production process. Every unit of production is tested for the standards specified. The units which do not meet the specifications are rejected. The rejected units are said to be of bad quality, as such they are not put to use. Statistical quality control is the procedure for the control of quality by the application of the theory of probability to the results of inspection of samples of the population. Sampling plans are used in the area of quality and reliability analysis. When the quality of product is related to its lifetime, it is called as life test.

In most of the life testing sampling plans a common constraint is the duration of the total time spent on the test. It is usual to terminate a life test by prefixed time and record the number of failures till that time. If the number of observed failures at the end of the fixed time is not greater than the specified acceptance number, then the lot will be accepted. The test may get terminated before the pre specified time is reached when the number of failures exceeds the acceptance number in which case the decision is to reject the lot. Two risks are continually associated to a time truncated acceptance sampling plan. The probability of accepting a bad lot is known as the consumer's risk and the probability of rejecting a good lot is called the producer's risk. For such a truncated life test and the associated decision rule we are interested in obtaining the smallest sample size to arrive at a decision where the life time of an item follows Akash Distribution.

From Cameron table (1952), one can observe a jump between the operating ratios of single sampling plan with c = 0 and c = 1 and slow reduction of operating ratios for other values of c. It may also be seen that, in between the operating characteristic (OC) curves of single sampling plan with c = 0 and c = 1 plans, there is a vast gap to be filled which leads one to assess the possibility of designing plans having OC curves lying between the OC curves of c = 0 and c = 1 plan. To overcome such situation Craig (1981) have proposed Double Sampling Plan with acceptance number 0 and 1 and rejection number 2.Vijayaragavan(1990), has presented tables for the selection of DSP (0,1) plan for attributes under Poisson and Binomial conditions of sampling. Sudamani Ramaswamy and Sutharani (2014), discussed the special purpose double sampling plan of type DSP (0,1) for truncated life test using minimum angle method. Sudamani Ramaswamy and Jaishree (2014) proposed a new approach of designing special purpose double sampling plan of type DSP (0,1) for truncated life test assuming that the experiment is truncated at pre-assigned time, when the lifetime of the items follows different distributions. In this chapter Double Sampling Plan of type DSP (0,1) for truncated life test is developed, assuming that the experiment is truncated at pre-assigned time when the lifetime of the items follow Akash Distribution.

AKASH DISTRIBUTION:

The probability density function of Akash Distribution is defined as

$$f_{AD}(x,\delta) = \frac{\delta^3}{\delta^2 + 2}(1 + x^2)e^{-\delta x}, \quad \delta>0, x>0 \qquad (1)$$

and its corresponding cumulative distribution function is given by

$$f_{AD}(x,\delta) = 1 - \left[1 + \frac{\delta x}{\delta^2 + 2}(\delta x + 2)\right]e^{-\delta x} \qquad (2)$$

The r^{th} moment of the AD distribution is given

$$E(X^k) = \frac{k\left[\delta^2 + (k+1)(k+2)\right]}{\delta^k(\delta^2 + 2)}; \quad k=1,2,\ldots.., \qquad (3)$$

The mean of the Akash distribution iss

$$E(X) = \frac{\delta^2 + 6}{\delta(\delta^2 + 2)} \qquad (4)$$

The coefficient of variation and coefficient of skewness respectively, are

$$CV = \frac{\sigma}{\mu} = \frac{\sqrt{\delta^4 + 16\delta^2 + 12}}{\delta^2 + 6} \quad \text{and}$$

$$Sk = \frac{2(\delta^6 + 30\delta^4 + 36\delta^2 + 24)}{\sqrt{(\delta^4 + 16\delta^2 + 24)^3}}$$

The corresponding hazard rate function and mean residual life function are

$$h(x,\delta) = \frac{f(x,\delta)}{1 - F(x,\delta)} = \frac{\delta^3(1 + x^2)}{\delta x(\delta x + 2) + (\delta^2 + 2)} \qquad (5)$$

Operating procedure of special purpose double sampling plan of type DSP (0,1)

According to Hald (1981), the operating procedure of DSP (0,1) is as follows:

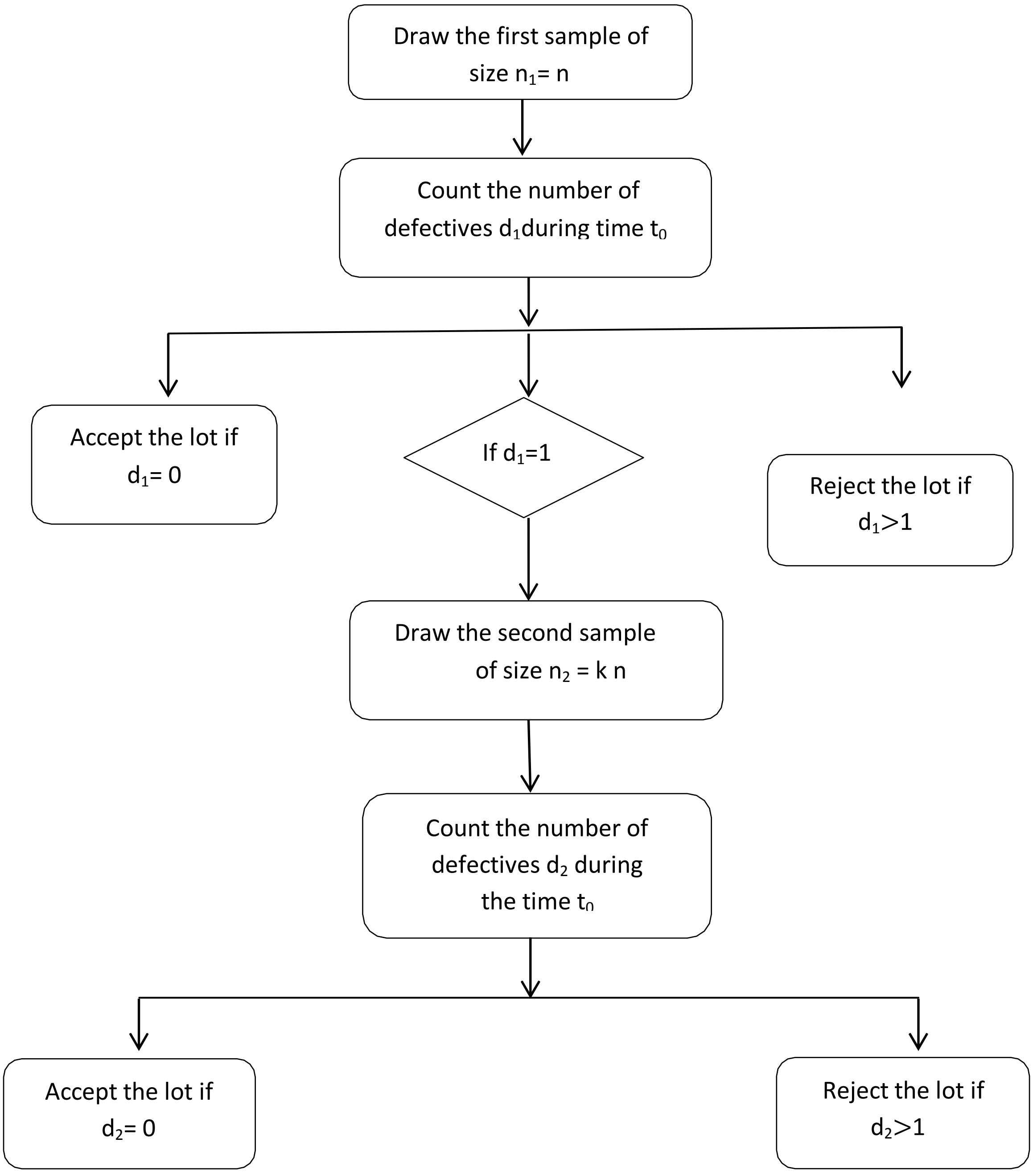
- From a lot, select a sample of size n_1, and observe the number of defectives ,d_1.
- If d_1=0, accept the lot; If $d_1>1$, reject the lot.
- If d_1=1, select a second sample of size n_2 and observe d_2.
- If d_2=0, accept the lot, otherwise reject the lot.

Operating procedure for DSP (0,1) sampling plan for truncated life test

- From a lot, select a sample of size n_1, and observe the number of defectives d_1, during the time t_0.
- If d_1=0,accept the lot ; If $d_1>1$,reject the lot;
- If d_1=1, select a second sample of size $n_2$and observe d_2, during the time t_0.
- If d_2=0, accept the lot, otherwise reject the lot.

The following is the operating procedure for special purpose double sampling plan for life test in the form of a flowchart.

Flow Chart



Design of the Sampling Plan

It is assumed that the lot size is large enough to use binomial distribution to find the probability of acceptance. The probability of acceptance L (p) for this sampling plan is calculated using the following equation.

$$L\,(p) = (1-p)^{n1} + n_1 p(1-p)^{n1+n2-1} \quad (6)$$

Where $n_1 = n$ and $n_2 = kn$ and p is the failure probability.

The required sample size n is the smallest positive integer that satisfies the following inequality.

$$L\,(p) = (1-p_0)^{n1} + n_1\, p_0\, (1-p_0)^{n1+n2-1} \leq 1-P^{*} \quad (7)$$

The minimum values of $n_1 = n$ satisfying inequality (3.2) are obtained and given in Table 3.1 for various values of β and t/μ_0.

By fixing the time termination ratio t/μ_0 as 0.628, 0.942, 1.257, 1.571, 2.356, 3.141and 4.712, the consumer's risk P^* as 0.75, 0.90, 0.95, 0.99 and the mean ratio μ/μ_0 = 2, 4, 6, 8, 10, 12, we can find the size of the first and the second samples n_1 and n_2 by substituting the failure probability p in the equation (6) and satisfying the inequality (7) at worst case ($\mu=\mu_0$).The sample sizes are calculated for the Akash Distribution and are presented in Table 1.

Operating Characteristics (OC) Curve

The OC function of the sampling plan is the probability of accepting a lot and is given by

$$L(p)=(1-p)^{n1}+n_1p(1-p)^{n1+n2-1} \quad (8)$$

where $p=F(t,B,\delta)$ is treated as a function of lot quality.

Operating Characteristics (OC) Curve

The OC function of the sampling plan is the probability of accepting a lot and is given by

$$L(p)=(1-p)^{n1}+n_1p(1-p)^{n1+n2-1} \quad (9)$$

where $p=F(t,B,\delta)$ is treated as a function of lot quality.

The Operating Characteristic function value for the DSP (0, 1) when the parameters of Akash Distribution are δ = 2 are calculated for different values of μ/μ_0=2, 4, 6, 8, 10 and 12, t/μ_0= 0.628, 0.942, 1.257, 1.571, 2.356, 3.141 and 4.712, and consumer's risk 1- p* = 0.25,0.10,0.05,0.01are calculated and presented in Table (3.2).

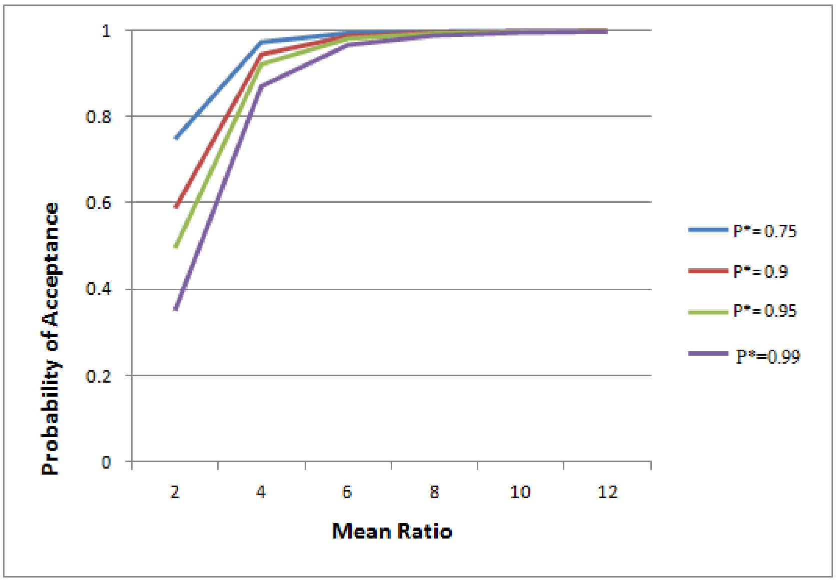


Figure 1 : OC values vs mean ratio μ/μ_0 with experiment time ratio t/μ_0= 0.628

EXAMPLE

Assume that an experimenter wants to establish that the lifetime of the electrical devices produced in the factory ensures that the true unknown mean life is at least 1000 hours with consumer's risk $\beta = 0.10$.It is desired to stop the experiment at t = 3927 hours. It is assumed that k = 2. Based on consumer's risk values and the test termination time, the minimum sample size is determined using the special purpose double sampling plan of type DSP (0,1) for truncated life test. Let the distribution followed be Akash Distribution, then we get the sample size as 2 from Table 1. The lot is accepted, at a given mean ratio μ/μ_0=2, during 3927 hours, with the plan parameters $(n_1, n_2) = (2, 2)$ satisfying the consumer's risk. From the Table 2, one can observe that the probability of acceptance for this sampling, when μ/μ_0 = 2 is 0.0258.For the same measurements and plan parameters the probability of acceptance is 0.6087, when ratio of unknown average life is 12.

Table 1: Minimum Sample Size for DSP (0, 1) plan when the life time of the items follows Akash Distribution with δ=2.

P^*	k	t/μ_0							
		0.628	0.942	1.257	1.571	2.356	3.141	3.927	4.712
0.75	0	5	4	3	3	2	2	2	2
	1	3	2	2	2	1	1	1	1
	2	3	2	2	2	1	1	1	1
	3	3	2	2	2	1	1	1	1
	4	3	2	2	2	1	1	1	1
	5	3	2	2	2	1	1	1	1
	6	3	2	2	2	1	1	1	1
	7	3	2	2	2	1	1	1	1
	8	3	2	2	2	1	1	1	1
	9	3	3	2	2	1	1	1	1
	10	3	3	2	2	1	1	1	1
0.90	0	7	5	4	4	3	2	2	2
	1	4	3	3	2	2	1	1	1
	2	4	3	3	2	2	1	1	1
	3	4	3	3	2	2	1	1	1
	4	4	3	3	2	2	1	1	1
	5	4	3	3	2	2	1	1	1
	6	4	3	3	2	2	1	1	1
	7	4	3	3	2	2	1	1	1
	8	4	3	3	2	2	1	1	1
	9	4	3	3	2	2	1	1	1
	10	4	3	3	2	2	1	1	1

	0	8	6	5	4	3	3	2	2
	1	5	4	3	3	2	2	1	1

0.95	2	5	4	3	3	2	2	1	1
	3	5	4	3	3	2	2	1	1
	4	5	4	3	3	2	2	1	1
	5	5	4	3	3	2	2	1	1
	6	5	4	3	3	2	2	1	1
	7	5	4	3	3	2	2	1	1
	8	5	4	3	3	2	2	1	1
	9	5	4	3	3	2	2	1	1
	10	5	4	3	3	2	2	1	1
0.99	0	11	8	6	4	4	3	3	2
	1	8	6	4	2	2	2	2	1
	2	8	6	4	2	2	2	2	1
	3	8	6	4	2	2	2	2	1
	4	8	6	4	2	2	2	2	1
	5	8	6	4	2	2	2	2	1
	6	8	6	4	2	2	2	2	1
	7	8	6	4	2	2	2	2	1
	8	8	6	4	2	2	2	2	1
	9	8	6	4	2	2	2	2	1
	10	8	6	4	2	2	2	2	1

Table 2: Operating Characteristics for DSP (0,1) with k=2,when the life time of the items follows Akash Distribution

P^*	n	t/μ_0	μ/μ_0					
			2	4	6	8	10	12
0.75	5	0.628	0.2076	0.4565	0.6279	0.7442	0.7836	0.8224
	4	0.942	0.1552	0.4274	0.5622	0.6853	0.7495	0.8133
	4	1.257	0.0806	0.2638	0.4274	0.5991	0.6224	0.7173
	3	1.571	0.1076	0.1674	0.5191	0.6371	0.7117	0.7367
	3	2.356	0.0362	0.1996	0.3242	0.4339	0.5650	0.6371
	2	3.141	0.0539	0.2452	0.4067	0.5380	0.6268	0.7174

	2	3.927	0.0258	0.1631	0.3338	0.4703	0.5380	0.6087
	1	4.712	0.0974	0.4030	0.5871	0.6980	0.7769	0.8181
0.90	7	0.628	0.1031	0.3000	0.4738	0.6123	0.6635	0.7165
	6	0.942	0.0575	0.2445	0.3699	0.5067	0.5880	0.6765
	6	1.257	0.0222	0.1218	0.2445	0.4008	0.4340	0.5464
	5	1.571	0.0230	0.0463	0.2793	0.3984	0.4879	0.5208
	4	2.356	0.0119	0.1091	0.2038	0.2989	0.4274	0.5053
	3	3.141	0.0122	0.1076	0.2234	0.3410	0.4339	0.5418
	2	3.927	0.0258	0.1631	0.3338	0.4703	0.5380	0.6087
	1	4.712	0.0974	0.4030	0.5871	0.6980	0.7769	0.8181
0.95	9	0.628	0.0525	0.1990	0.3554	0.4977	0.5545	0.6159
	7	0.942	0.0354	0.1864	0.3000	0.4334	0.5172	0.6123
	6	1.257	0.0222	0.1218	0.2445	0.4008	0.4340	0.5464
	5	1.571	0.0230	0.0463	0.2793	0.3984	0.4879	0.5208
	4	2.356	0.0119	0.1091	0.2038	0.2989	0.4274	0.5053
	3	3.141	0.0122	0.1076	0.2234	0.3410	0.4339	0.5418
	2	3.927	0.0258	0.1631	0.3338	0.4703	0.5380	0.0687
	2	4.712	0.0081	0.1141	0.2452	0.3621	0.4703	0.5380
0.99	14	0.628	0.0101	0.0748	0.1759	0.2934	0.3479	0.4121
	13	0.942	0.0020	0.0398	0.0906	0.1721	0.2369	0.3259
	10	1.257	0.0017	0.0283	0.0850	0.1851	0.2103	0.3080
	8	1.571	0.0024	0.0072	0.1148	0.1972	0.2711	0.3011
	6	2.356	0.0013	0.0345	0.0844	0.1456	0.2445	0.3141
	4	3.141	0.0028	0.0493	0.1261	0.2176	0.2989	0.4034
	2	3.927	0.0041	0.0603	0.1674	0.2776	0.3410	0.4141
	2	4.712	0.0081	0.1141	0.2452	0.3621	0.4703	0.5380

II. CONCLUSION

It is observed from Figure 1 and from Table 2 that the operating characteristics values of Akash Distribution increases. For various experiment time ratio, the minimum sample size required to make a decision increases with an increases in the confidence level. This sampling plan can be suggested for the industrial purposes to save time and cost of the life test experiments.

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